

## DRAFT FORKLIFT PROJECT CRITERIA

This document presents proposed project criteria for forklift equipment funding eligibility under the Carl Moyer Memorial Air Quality Standards Attainment Program (Carl Moyer Program). Also included is an overview of applicable regulations pertaining to forklifts, available control technology, examples of potential projects, and emission reduction and cost-effectiveness calculation methodologies.

### A. Forklift Equipment

Forklifts are used in a wide variety of applications, including, but not limited to, manufacturing, construction, retail, meat and poultry processing, lumber and building supplies, trades, agriculture, and a variety of warehouse operations. Forklifts can be powered by electric motors or by internal combustion engines (ICEs).

The Industrial Truck Association (ITA) has defined seven classes of forklifts. These classes are defined by the type of engine, work environment (indoors, outdoors, narrow aisle, smooth or rough surfaces), operator positions (sit down or standing), and equipment characteristics (type of tire, maximum grade). Several classes are further divided by operating characteristics. The following are the forklift classifications:

- **Class 1** are electric motor trucks with cushion or pneumatic (air filled) tires. Class I forklifts include four subcategories, or lift codes, which are:

Lift Code 1	Counterbalanced rider type, stand-up
Lift Code 4	Three-wheel electric, sit down
Lift Code 5	Counter balanced rider, cushion tire, sit-down
Lift Code 6	Counter balanced rider, sit-down rider (includes pneumatic tire models)
- **Class 2** forklifts are electric motor narrow aisle trucks with solid tires.
- **Class 3** forklifts include electric hand trucks or hand/rider trucks with solid tires.
- **Class 4** forklifts are ICE sit down rider forklifts with cushion tires and generally suitable for indoor use on hard surfaces.
- **Class 5** forklifts are ICE sit down rider forklifts with pneumatic tires. These are typically used outdoors, on rough surfaces, or significant inclines.
- **Class 6** trucks can be either electric or ICE powered. These are ride on units with the ability to tow at least 1,000 pounds. This class is designed to tow cargo rather than lift it.
- **Class 7** trucks are rough terrain forklift trucks with pneumatic tires. Class 7 trucks are almost exclusively powered by diesel engines, and are used outdoors.

## B. Emission Inventory

According to the ARB off-road emissions inventory, there were more than 39,000 ICE forklifts with engines greater than 50 horsepower used in industrial applications in California in 1995. These estimates do not include large terrain forklifts or forklifts used at airport operations. Estimates for forklifts used in airport operations are discussed in the document pertaining to airport ground support equipment. Total NO<sub>x</sub> emissions from industrial forklifts greater than 50 horsepower in California are estimated to be 62.1 tons per day in 1995, and are estimated to be 37.1 tons per day in 2010. ICE forklifts are fueled with gasoline, propane, natural gas, or diesel.

Table 1 contains ICE forklift population and NO<sub>x</sub> emission estimates for 1995. The emission estimates for propane, gas and compressed natural gas forklifts have already been approved by ARB. Emission estimates for diesel forklifts are pending Board approval.

<b>Table 1 1995 Population and NO<sub>x</sub> Emission Estimates For Industrial Forklifts with Internal Combustion Engines California and South Coast Air Basin Data</b>						
<b>Horsepower Range</b>	<b>Year</b>	<b>Fuel</b>	<b>Population</b>		<b>NO<sub>x</sub> Emission (tons per day)</b>	
			<b>SCAB</b>	<b>State</b>	<b>SCAB</b>	<b>State</b>
50 ≤ hp < 120	1995	Gasoline	4,610	9,318	6.5	13.1
50 ≤ hp < 120	1995	CNG, Propane	9,914	17,638	12.3	22.0
50 ≤ hp < 120	1995	Diesel	4,990	10,060	10.1	19.4
120 ≤ hp < 175	1995	Gasoline	168	340	0.6	1.1
120 ≤ hp < 175	1995	CNG, Propane	362	645	1.0	1.7
120 ≤ hp < 175	1995	Diesel	474	956	1.5	2.9
> 175 hp	1995	Diesel	205	414	1.0	1.9
<b>Total</b>			<b>15,733</b>	<b>39,371</b>	<b>33.0</b>	<b>62.1</b>

The ARB inventory does not contain information on the number of electric forklifts in California. Most of the information on the type of forklifts bought and used is considered to be confidential within the industry. Forklift population estimates that have been developed by EPRI and other sources generally rely on ITA shipment data. Data reviewed by ARB staff indicates that there are about 70,000 electric forklifts in California. Roughly 50,000 of those are the smaller (class 3) hand trucks and narrow aisle trucks, and about 20,000 of those are electric rider forklifts. Electric forklifts have zero exhaust emissions.

## C. Emission Standards

Emission standards for forklifts are contained in ARB and United States Environmental Protection Agency's (U.S EPA) emission standards for off-road equipment. Internal combustion engine forklifts can either be powered by diesel engines (compression ignition engines) or by spark-ignited engines (which use gasoline, compressed natural gas, or propane fuel). There are separate emission standards for large spark-ignited engines and compression-ignition engines.

Off-road equipment is also split into two broad categories: less than 175 horsepower, and equal to or greater than 175 horsepower. Both of these categories include forklifts. Currently, ARB is preempted from regulating new farm and construction equipment less than 175 horsepower. However, ARB has the authority to regulate off-road equipment equal to or greater than 175 horsepower and non-preempted off-road equipment less than 175 horsepower.

### 1. Large Spark-Ignited Off-Road Engine Standards

Forklifts with spark-ignited engines are commonly used indoors, and typically have lift capacities between 3,000 and 16,000 pounds. A report prepared for the Natural Gas Institute indicated that about 45% of spark-ignited forklifts (class 4 and 5) have engines rated 50 horsepower or lower. On an ICE forklift, a 50 horsepower engine generally has a 6000 pound lift capacity or greater. Propane is the fuel that is most widely used in spark-ignited engines, compared to gasoline or compressed natural gas.

Spark-ignited engines greater than 25 horsepower are classified as large spark-ignited engines by ARB. Current model year large spark-ignited engines are not subject to any ARB or U.S. EPA emission standards. ARB has approved standards for new large spark-ignited off road engines to be implemented beginning with the 2001 model year. The regulations establish exhaust emission standards and test procedures. Table 2 contains the emission standards applicable to large spark-ignited engines that were approved by ARB.

<b>Table 2 Exhaust Emission Standards New Large Spark-ignited Engines</b>				
<b>Year</b>	<b>Engine Size</b>	<b>NMHC + NO<sub>x</sub> (g/bhp-hr)</b>	<b>CO (g/bhp-hr)</b>	<b>Durability Period</b>
2002 & later	<1.0 liter	9.0	410	1000 hours or 2 years
2001-2003 (Phase-in)	>1.0 liter	3.0	37	N/A
2004-2006	>1.0 liter	3.0	37	3500 hours or 5 years
2007 & later	>1.0 liter	3.0	37	5000 hours or 7 years

*\* The standard for in-use compliance for engine families certified to the standards noted above shall be 4.0 g/bhp-hr (5.4 g/kW-hr) hydrocarbon plus oxides of nitrogen and 50.0 g/bhp-hr (67 g/kW-hr) carbon monoxide for a useful life of 5000 hours or 7 years.*

## 2. Diesel Off-Road Engine Standards

Compression-ignition engines (diesel) are often used to power forklifts that have large payload requirements. Almost all diesel forklifts have lift capacities over 6,000 pounds, and are available with lift capacities exceeding 40,000 pounds.

Diesel forklifts are subject to off-road compression ignition engine standards. ARB has adopted emission standards for off-road diesel cycle engines equal to or greater than 175 horsepower. The U.S. EPA has adopted NO<sub>x</sub> emission standards for off-road diesel cycle engines at or above 50 horsepower. The U.S. EPA rule aligns with California's first tier regulations for engines 175 horsepower and greater and took effect in 1996. The U.S. EPA rule also took effect in 1997 for off-road diesel cycle engines at or above 100 horsepower but less than 175 horsepower and in 1998 for off-road diesel cycle engines at or above 50 horsepower but less than 100 horsepower. The combination of ARB and U.S. EPA emission standards means that all of today's new off-road diesel cycle engines, including forklifts, 50 to 750 horsepower have to be certified to meet a NO<sub>x</sub> emission standard of 6.9 g/bhp-hr.

U.S. EPA, ARB, and off-road diesel engine manufacturers have signed a Statement of Principles (SOP) that sets forth comprehensive future emission standards for compression ignition (diesel) off-road engines. The SOP provides for NO<sub>x</sub>, PM, and carbon monoxide (CO) emission standards for new engines to be phased-in from 2003 through 2008. U.S. EPA has adopted regulations for off-road diesel equipment consistent with the emission levels contained in the SOP. The ARB intends to revise California's regulations for off-road equipment to harmonize with federal regulations. Table 3 contains the applicable U.S. EPA standards for off-road diesel engines.

<b>Table 3</b> <b>U.S. EPA Exhaust Emission Standards for</b> <b>Off-Road Diesel Engines</b>								
<b>Rated Power (horsepower)</b>	<b>NO<sub>x</sub> and PM Emission Standards (g/bhp-hr)</b>							
	<b>1997/8</b>		<b>2003/2004</b>		<b>2007</b>		<b>2008</b>	
	<b>NO<sub>x</sub></b>	<b>PM</b>	<b>NMHC +NO<sub>x</sub></b>	<b>PM</b>	<b>NMHC + NO<sub>x</sub></b>	<b>PM</b>	<b>NMHC + NO<sub>x</sub></b>	<b>PM</b>
50 ≤ hp < 100	6.9	--	5.6	0.30	5.6	0.30	3.5	0.30
100 ≤ hp < 175	6.9	--	4.9	0.30	3.0	0.22	3.0	0.22

## **D. Electric Forklifts**

Electric forklifts include electric motor trucks with cushion or pneumatic tires (Class 1); electric motor narrow aisle trucks (Class 2); and electric hand trucks or hand/rider trucks (Class 3). Class 1 electric forklifts are available in a wide variety of lift capacities from 3000 pounds to 20,000 or greater pounds. According to market data evaluated by ARB, most class 1 forklifts sold today in the U.S. are in the 3,000-6000 pound lift capacity range and there does not appear to have been a large penetration of electric class 1 forklifts with lift capacities greater than 6000 pounds in the current California or U.S. market.

Electric forklifts are most typically used in indoor materials handling applications that do not require large lift capacities (i.e., warehouse/retail operations). There are some applications where electric forklifts are used extensively, primarily for worker safety. These applications include confined spaces, cold storage, and food retail (primarily grocery stores).

Although electric forklifts are primarily designed for indoor operations, a number of manufacturer's are also including equipment features which enable electric models to be used a wider variety of environments. These features include pneumatic tires (air filled), which allow the forklift to be used on unimproved surfaces. Another feature is water proofing trucks or sealing the electronic compartment to make them more water resistant for outdoor conditions. Class 1 forklifts (electric) compete directly with ICE forklifts for many of the same work applications.

Electric forklifts have no exhaust emissions, and thus can provide significant air quality benefits. EPRI has prepared several reports on electric forklifts which identify other benefits of electric forklift usage besides improved air quality. One benefit is that electric forklifts have lower life cycle costs when compared with ICE models. This is due to lower maintenance costs, lower fueling costs, and longer useful life for an electric forklift. Although the initial capital cost is higher for an electric forklift as compared with the ICE forklift, the incremental cost can be recouped during the useful life of the electric forklift. Because of the financial benefits to the end user, electric forklifts are already prevalent in the general market.

## **E. Control Strategies**

Electric forklifts have been widely used for a number of years in the United States. Increasing the use of electric forklifts by replacing ICE forklifts with electric forklifts would reduce NOx emissions. Replacing an older electric forklift with a newer electric model, however, does not reduce emissions. The project criteria for forklifts have been designed to encourage the replacement of an ICE forklift with an electric forklift. The project criteria for forklifts have been designed to exclude projects where "electric to electric" replacements are likely to occur or where electric forklifts already dominate the market.

### **1. Forklift Class**

Class 1 forklifts are the electric models that compete with ICE forklifts because they are similar in design and specification. Class 1 forklifts can be used in many of the same work

applications as an ICE (class 4 or 5) forklift. Increasing the use of class 1 forklifts relative to class 4 and 5 forklifts would reduce NOx emissions. Class 2 and 3 forklifts, however, are used in applications where ICE forklifts are neither practical nor available. Since these classes are solely electric forklifts, and “electric-to-electric” replacements do not yield NOx reductions, Class 2 and 3 would also be excluded from funding under the Carl Moyer Program.

Rough terrain forklifts (Class 7) are primarily powered by diesel engines. Electric or alternatively fueled options are not currently available for Class 7 forklifts. Hence, Class 7 forklifts would be excluded from the Carl Moyer Program.

## **2. Industry Application**

The most viable control strategies would include funding electric forklifts that replace ICE forklifts, where electric forklifts are not commonly used. These control strategies would include construction, millwork, cargo handling, lumber, plywood, foundries, and metal work.

Conversely, there are several applications where electric forklifts are used extensively, as compared to ICE forklifts. These industrial applications include confined spaces, cold storage, and food retail (primarily grocery stores). Since electric forklifts are commonly used in these industrial applications, “electric-to-electric” replacements would also be common. Hence, forklift purchases or replacements in industries that include confined spaces, cold storage, and food stores are excluded from the Carl Moyer Program.

## **3. Forklift Rental**

Market data reviewed prepared for the Natural Gas Institute indicates several interesting trends regarding forklift usage and ownership. Approximately 50% of forklifts are owned by the end user; the other 50% are rented or leased. This can include either short-term rental agreements as well as full service leases. Both electric and ICE forklifts are leased and rented. Full service leases are an attractive option to many companies because it reduces the up-front capital costs associated with the purchase of new forklift equipment. Rented and leased equipment can be deployed in a wide variety of fleets and work applications. There is no practical way to ensure that leased electric forklifts are replacing an ICE forklift, and not an “electric-to-electric” replacement. Therefore, the Carl Moyer Program will only fund electric forklifts purchased and intended for use by the purchaser.

## **4. Used Forklifts**

The report prepared for the Natural Gas Institute also indicates that the average annual average hours of usage varies significantly between industries and facilities. The industry average is 2,250 hours/year for electric forklifts and 1900 hours/year for an ICE forklift. This report also estimated that one third of electric forklifts that are purchased are actually used. New electric forklift purchasers often record twice the operating hours as used forklift purchasers. Because of the reduced usage and life expectancy of older equipment, the Carl Moyer Program will only fund purchases of new electric forklifts.

## **5. Battery Charger**

One good indication that a business or fleet is not currently using an electric forklift is whether they have battery charging equipment. In order to ensure that the Carl Moyer Program is funding replacement of an ICE forklift with an electric forklift, and not an electric to electric replacement, all projects will be required to purchase battery charging equipment.

## **F. Project Criteria**

In order for a forklift project to qualify for funding under the Carl Moyer Program, the incremental cost of a forklift must meet a cost-effectiveness criterion of \$12,000 per ton of NO<sub>x</sub> reduced. The forklift must also be operated for at least five years from the time it is first put into operation, and for at least 75 percent of the time in California. In addition, a forklift project must meet the following specific project criteria:

- Eligible equipment are four wheel counter-balanced sit-down electric forklifts, rated class 1, lift codes 5 or 6 plus one battery pack for each forklift purchased.
- For existing facilities, all forklifts must be purchased new, and rated for a minimum lift capacity of 6000 pounds or greater.
- For new and expanding facilities/operations, all forklifts must be purchased new, and rated for a minimum lift capacity of 7000 pounds or greater.
- All eligible projects must also include the installation of battery charging equipment. Battery charging equipment is considered infrastructure and should not be included in project costs.
- For existing facilities, the ICE forklift which is being replaced must have an engine rated for 50 horsepower or greater.
- NO<sub>x</sub> reductions obtained through this program must not be required by any existing regulations or binding agreements.
- Forklifts used in commercial (passenger) airport operations were not included in the forklift emissions inventory. They may be eligible for funding provided they meet both forklift and GSE project criteria.
- All forklifts must be purchased by the user. Organizations or businesses which rent or lease forklifts are not eligible for funding. Also exempted are rental or leased equipment costs.
- The following are not eligible for funding under this program: food retail stores, cold storage, and confined space operations.

- The following forklift purchases are not eligible: stand up electric forklifts (class 1, lift code 1), three-wheel electric sit-down rider (class 1, lift code 4), narrow aisle electric forklifts (class 2) or hand/rider trucks (class 3).

## **G. Sample Application**

In order to qualify for incentive funds, districts will make applications available and solicit bids for reduced-emission projects from off-road diesel equipment operators. A sample application form is included in the Appendix. The applicant must provide at least the following information, as listed in Table 4 below:

<b>Table 4</b> <b>Minimum Application Information</b>	
1. Company name	12. Project life (min 5 years)
2. Project name	13. Model & Manufacturer of ICE Forklift Being Replaced (if an existing business)
3. Air district	14. Estimated annual hours of operation
4. Business or industry of applicant	15. % operated in California
5. Is the electric forklift replacing an older non-electric forklift, part of operation or facility expansion, or for a brand new facility/operation?	16. If facility/operation expansion, list current facility square feet and expanded facility square feet.
6. Does the applicant rent or lease forklifts to others?	17. If new facility/operation, list new facility square feet.
7. Type of forklift purchased	18. Incentive amount requested
8. Maximum rated lift capacity (in pounds)	19. Baseline NOx emissions
9. Manufacturer and model number of new forklift	20. New reduced-NOx emissions
10. Cost of forklift (including 1 battery pack)	21. Baseline cost (cost for non-electric forklift)
11. Cost of charging equipment purchased	

## **H. Emission Reduction and Cost-Effectiveness**

### **1. Emission Reduction Calculation**

The emission reduction benefit will be calculated for NOx emissions only and will be determined using the annual hours of operation. Annual NOx emission reductions are determined by multiplying the difference in the NOx emission levels by the rated horsepower of the engine, the load factor, and the hours the engine is expected to operate per year. The load factor is an indication of the amount of work done, on average, by an engine in a particular application, given as a fraction of the rated horsepower of that engine. If the actual load factor is known for an engine it should be used in calculating emission reductions. If the actual load factor is not known, the default value of 0.30 will be used; this is the load factor used in the ARB inventory for all non-construction forklifts (all fuels). Another variable in determining emission reductions is the number of hours the equipment operates. If actual hours of equipment operation are not available, the default value of 1900 annual hours should be used to calculate emission reductions.



<p align="center"><b>Table 5</b>  <b>Baseline Emission Rates for</b>  <b>Forklift Engines</b></p>		
<b>Rated Power (horsepower)</b>	<b>Type of Engine</b>	<b>NOx Emission Rates</b>
>50 horsepower	Compression ignition (diesel)	6.9 (g/bhp-hr)
> 50 horsepower	Large Spark-ignited (propane) Uncontrolled	10.5 (g/bhp-hr)
> 50 <120 horsepower	Large Spark-ignited (gasoline) Uncontrolled	11.8 (g/bhp-hr)
>120 horsepower	Large Spark-ignited (gasoline) Uncontrolled	12.9 (g/bhp-hr)

## 2. Cost-Effectiveness Calculation

The portion of the cost for an electric forklift project to be funded through the Carl Moyer Program is the difference between the cost of purchasing a new electric forklift and buying a conventional forklift. Only the amount of money provided by the Carl Moyer program and any local district match funds can be used in the cost-effectiveness calculations. The one-time incentive grant amount is to be amortized over the expected project life (at least five years) with a discount rate of five percent. The amortization formula (given below) yields a capital recovery factor, when multiplied with the initial capital cost, gives the annual cost of a project over its expected lifetime.

$$\text{Capital Recovery Factor (CRF)} = [(1 + i)^n (i)] / [(1 + i)^n - 1]$$

Where,

$i$  = discount rate (5 percent)

$n$  = project life (at least five years)

The discount rate of five percent reflects the opportunity cost of public funds for the Carl Moyer Program. This is the level of earning that could be reasonably expected by investing state funds in various financial instruments, such as U.S. Treasury securities. Cost-effectiveness is determined by dividing the annualized cost by the annual NOx emission reductions. Example calculations for forklift projects are provided below.

## 3. Examples

For the purposes of explaining the emission reduction and the cost effectiveness calculations from a particular forklift project, two examples are presented below. The first example describes the calculations based on replacing a diesel forklift with an electric counter balanced sit down rider electric (class 1) forklift, and the second example shows calculation for the replacement of a propane forklift.

### **Example 1 – Calculations for replacement of a diesel forklift, based on hours of operation.**

A forklift owner applies for a Carl Moyer Program grant for the purchase of a new counter balanced sit down rider electric forklift to replace a diesel powered ICE forklift. The forklift

owner has decided to purchase a new electric forklift instead of purchasing a new diesel forklift certified to a 6.9 g/bhp-hr NOX standard. The cost of the new electric forklift is \$39,900, plus \$4000 for the battery, whereas the cost to buy a new diesel ICE forklift is \$35,730. The new forklift will operate 1900 hours annually and will operate 100 percent of the time in California.

### Emission Reduction Calculation

$$\text{Annual NOx Reductions (tons/year)} = \frac{[(\text{Baseline NOx}) - (\text{Reduced NOx})] * (\text{Horsepower Rating}) * (\text{Annual Operating Hours}) * (\text{Load Factor}) * (\% \text{ Op. in CA})}{(\text{ton} / 907,200 \text{ grams})}$$

Where,

<b>Baseline NOx Emissions</b>	= Emission level from a new diesel forklift engine: 6.9 g/bhp-hr
<b>Reduced NOx Emissions</b>	= New electric forklift: 0 g/bhp-hr
<b>Rated Horsepower</b>	= 90 hp
<b>Annual Operating Hours</b>	= 1900 hours
<b>Load Factor</b>	= 0.30
<b>% Operated in CA</b>	= 1.0 (i.e., 100%)
<b>(ton/907,200 g)</b>	Converts grams to tons

Hence, estimated annual NOx reductions are:

$$((6.9 - 0) \text{ g/bhp-hr}) (90 \text{ hp}) (1900 \text{ hours/year}) (0.30) (1.0) * (\text{ton} / 907,200 \text{ g}) = \mathbf{0.39 \text{ tons/year}}$$

### Cost and Cost-Effectiveness Calculations

The annualized cost is based on the portion of incremental project costs funded by the Carl Moyer Program, the expected life of the project (5 years at a minimum), and the interest rate (5 percent) used to amortize the project cost over the project life. The incremental capital cost to the equipment owner for this purchase and the maximum amount that could be funded through the Carl Moyer Program fund are determined as follows:

<b>Total cost of new electric forklift</b>	= \$39,900 + \$4000=\$43,900
<b>Incremental Capital Cost</b>	= (\$43,900 - \$35,730=\$8,170
<b>Max. Amount Funded</b>	= \$8,170
<b>Capital Recovery</b>	= $[(1 + 0.05)^5 (0.05)] / [(1 + 0.05)^5 - 1] = 0.23$
<b>Annualized cost</b>	= (0.23)(\$8,170) = \$ 1,879/year
<b>Cost-Effectiveness</b>	= (\$1,879/year)/(0.39 tons/year) = <b>\$733/ton</b>

The project meets the cost-effectiveness limit of \$12,000/ton NOx reduced and is eligible for an incentive amount of \$8,170.

### **Example 2– Calculations for replacement of a propane forklift, based on hours of operation.**

A forklift owner applies for a Carl Moyer Program grant for the purchase of a new counter balanced sit down rider electric forklift to replace a propane powered ICE forklift. The forklift owner has decided to purchase a new electric forklift instead of purchasing a new propane forklift with uncontrolled emissions of 10.5 g/bhp-hr. The cost of the new electric forklift is

\$30,000 (including one battery pack), whereas the cost to buy a new propane forklift is \$25,000. The new forklift will operate 1900 hours annually and will operate 100 percent of the time in California.

### Emission Reduction Calculation

$$\text{Annual NOx Reductions (tons/year)} = \frac{[(\text{Baseline NOx}) - (\text{Reduced NOx})] * (\text{Horsepower Rating}) * (\text{Annual Operating Hours}) * (\text{Load Factor}) * (\% \text{ Op. in CA})}{907,200 \text{ grams}}$$

Where,

<b>Baseline NOx Emissions</b>	= Uncontrolled emission level from a new propane forklift engine: 10.5 g/bhp-hr
<b>Reduced NOx Emissions</b>	= New electric forklift: 0 g/bhp-hr
<b>Rated Horsepower</b>	= 60 hp
<b>Annual Operating Hours</b>	= 1900 hours
<b>Load Factor</b>	= 0.30
<b>% Operated in CA</b>	= 1.0 (i.e., 100%)
<b>(ton/907,200 g)</b>	Converts grams to tons

Hence, estimated annual NOx reductions are:

$$(10.5 - 0) \text{ g/bhp-hr} (60 \text{ hp}) (1900 \text{ hours/year}) (0.30) (1.0) * (\text{ton} / 907,200 \text{ g}) = \mathbf{0.40 \text{ tons/year}}$$

### Cost and Cost-Effectiveness Calculations

The annualized cost is based on the portion of incremental project costs funded by the Carl Moyer Program, the expected life of the project (5 years at a minimum), and the interest rate (5 percent) used to amortize the project cost over the project life. The incremental capital cost is reduced by 25% to reflect the lowered life cycle costs that will be realized during the project period from lower fuel and maintenance costs. The incremental capital cost to the equipment owner for this purchase and the maximum amount that could be funded through the Carl Moyer Program fund are determined as follows:

<b>Total cost of new electric forklift</b>	= \$30,000
<b>Incremental Capital Cost</b>	= (\$30,000 - \$25,000) = \$5,000
<b>Max. Amount Funded</b>	= \$5,000
<b>Capital Recovery</b>	= $[(1 + 0.05)^5 (0.05)] / [(1 + 0.05)^5 - 1] = 0.23$
<b>Annualized cost</b>	= (0.23)(\$5000) = \$ 1,150/year
<b>Cost-Effectiveness</b>	= (\$1,150/year)/(0.40 tons/year) = <b>\$460/ton</b>

The project meets the cost-effectiveness limit of \$12,000/ton NOx reduced and is eligible for an incentive amount of \$5,000.

## **I. Reporting and Monitoring**

During the project life, a district has the authority to conduct periodic checks or solicit operating records from the applicant that has received Carl Moyer funds for new electric forklift projects. This is to ensure that the equipment is operated as stated in the program application

Forklift owners participating in the Carl Moyer Program are required to keep appropriate records during the life of the project funded. Records must contain, at a minimum, total hours operated, amount of electricity used, and maintenance and repair information. Records must be retained and updated throughout the project life and made available at the request of the district.